92-06173/

Ontario

ORDER NO. 91-071
OCTOBER 1991
AGDEX 400

Factsheet

WATER QUALITY and PIG PERFORMANCE

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SURFACE AND GROUNDWATER

The quality of surface and groundwater for all livestock is affected by the water cycle and by the nature of the aquifer supplying the water.

Water Cycle describes the events by which water is circulated between atmosphere, land and oceans. The sun's energy evaporates water from oceans, lakes, rivers and soil. Water is released back to the land in the form of precipitation (rain and snow). Most of the precipitation is temporarily retained by the soil, then released back to the atmosphere from plants and through evaporation. Some of the remaining water runs off the land while the rest moves downward through the soil until it reaches the **zone of saturation**. At this zone, the water fills the pore spaces in the **overburden** (material above the bedrock) and cracks and fractures in the bedrock. The upper portion of the zone of saturation is called the **water table**. Some water from the water table will eventually filter back into oceans, streams and rivers (see Figure 1). In the zone of saturation, any material or formation capable of yielding water in usable amounts is called an **aquifer or water-bearing formation**. Aquifers may be in the bedrock or in the gravel and/or sand of the overburden.

Surface Water quality is affected by materials in run-off from rain and from materials in the water table. Surface water can easily become contaminated with bacteria, minerals, chemicals, heavy metals and algae from various sources.

Groundwater quality depends on the type of aquifer supplying the well with water; thus water from aquifers in limestone bedrock will likely contain high levels of calcium and magnesium. Bacterial and chemical contaminants are not naturally found in aquifers supplying water to deep wells. Their presence in such wells indicate a pollution problem. Pollution may be caused by cracked or faulty well casings, open well caps, or spills from a neighboring source.

Groundwater Availability and Supply records can be obtained from Water Well Records on file with the Ministry of the Environment (MOE). All well contractors must submit (by Regulation 612/84) a Well Water Record to the well owner and the Ministry upon completion of a new well. The record lists the well's location, owner's name, date of construction, geological log, well construction details, test results, well yield, water use, recommended pump setting, and the name and address of the licenced well contractor who drilled the well.

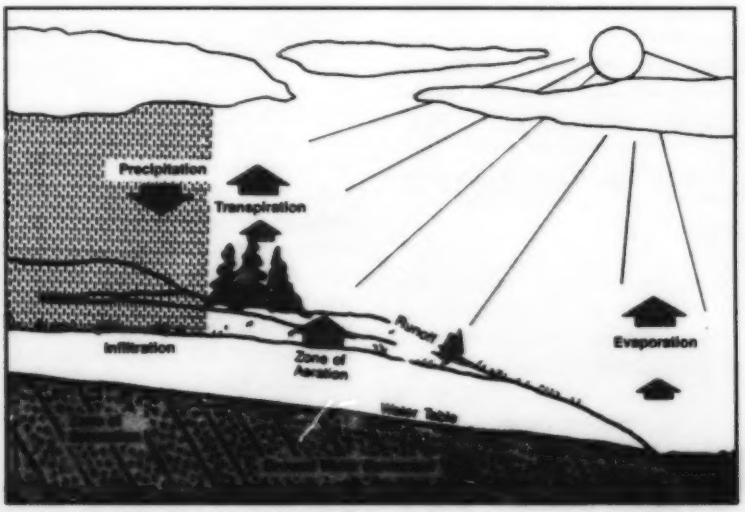

Figure 1. Water Cycle
(Courtesy: *Water Wells and Ground Water Supplies* – MOE, 1989)

BACTERIAL CONTAMINATION OF WATER

Animals can contaminate water with manure by direct contact or by runoff from faulty manure storages and handling. Internal parasites and diseases such as leptospirosis and salmonella can be transmitted through manure-contaminated water.

Indicators of bacterial contamination of water are: **total coliform** and **fecal coliform**. Total coliform are bacteria found in vegetation, animal wastes, sewage, and soil. Fecal coliform bacteria come from the intestines of warm-blooded animals; they die quickly when outside the body. Fecal coliform in water therefore indicates a recent, nearby problem.

Bacterial analysis of water is done by inoculating nutrient plates with water samples and incubating the plates for a period of time. Any resulting bacterial colonies are physically counted. These bacterial colonies are shown on a bacterial analysis report as "counts per 100 mL" of water.

If the number of **total coliform** colonies on the nutrient plate is more than 80, the additional colonies are not counted. Total coliform count is then shown on the lab report as ">80," with the symbol ">" meaning "more than." Similarly, if the number of **fecal coliform** colonies is more than 60, the fecal coliform count is shown as ">60."

Water samples can contain other organisms (such as yeasts and molds), as well as coliform bacteria. If these organisms make accurate coliform counts impossible, the number of bacterial colonies are estimated. The estimated counts are shown on the lab report along with the letters "EST," meaning estimated. If the nutrient plates are so overgrown with other organisms that the lab cannot tell whether or not coliform bacteria are present, the letters "O/G," meaning "over grown," are shown on the lab report.

Drinking water for human consumption should be **free** of total and fecal coliform bacteria. Water containing 10 counts or less of total coliform bacteria may still be safe to drink under specified conditions (contact your local Health Unit for advice). The number of fecal coliform counts in water which will affect pig performance is unknown; however, since fecal coliform bacteria indicate a pollution problem, all contaminated drinking water should be disinfected and the source of the pollution stopped.

TABLE 1. Canadian Water Quality Guidelines for Pigs.

Item	Recommended Maximum Limit (Mg/l or PPM)
Total Dissolved Solids (TDS)	3000
Salinity	3000 (see Table 2)
Calcium	1000
Sulfate	1000
Magnesium	400
Nitrate + Nitrite (N)	100
Nitrite (N)	10
Iron	no guideline established
Fluoride	2 (1 if present in feed)
blue-green algae	avoid heavy growths of algae

Source: Canadian Water Quality Guidelines - Canadian Council of Resource and Environment Ministers, 1987.

Bacterial Analysis of Water contact your **local Health Unit**. You can have your water tested free of charge only if your water may contain organisms which could be a threat to human or animal health; the Health Unit will not do routine bacterial testing. The Health Unit will provide you with water sample bottles and analysis forms. Submit the samples and completed forms within 24 hours of sample collection.

If the Health Unit's analysis confirms the bacterial problem, they may suggest the producer contact MOE or Ministry of Agriculture and Food (OMAF) for help in locating and solving the source of the problem.

MINERAL AND CHEMICAL CONTAMINATION OF WATER

The amount of materials in water which can be consumed by pigs without harm depends on: the amount of the same materials in feeds; the pigs' daily water requirement; the length of time the pigs are given the water; the pig's age and condition and the presence of interactive materials in both feeds and water. Materials such as salt can be consumed at high levels if the pigs are accustomed to such materials. Problems often occur when sources of water are suddenly switched.

Guidelines for livestock drinking water are shown in Table 1. For a more complete list of mineral, heavy metal and chemical contaminants, contact your local MOE office.

Total Dissolved Solids (TDS) is a measure of all materials (including salts) which are dissolved in the water. TDS is determined by evaporating a water sample at 100°C and weighing the resulting dry matter. Surface water often contains less than 300 mg/l of TDS. Some Ontario groundwaters and industrial waters contain high levels of TDS (such as 2000-3000 mg/l sulfates in the Niagara Peninsula). TDS should not exceed 3000 mg/l according to Canadian guidelines.

Conductivity is a measure of a water's ability to carry an electrical current. Many inorganic acids, bases, and salts are good conductors while organic compounds such as glucose are poor conductors. Conductivity can be used to indicate the total dissolved solids (TDS) content of water. Many laboratories include conductivity in their water test packages instead of TDS because conductivity is a simpler, more accurate test. Water temperature affects conductivity and should therefore be included in the report. Standard temperature for conductivity measurement is 25°C. For southern Ontario waters, conductivity can be correlated with TDS by multiplying conductivity (measured in micromhos/cm or micrsiemens/cm) by 0.55-0.75.

Magnesium when combined with sulfate can cause scouring (see comments under "sulfate"). Magnesium contributes to water hardness, and like calcium, can form scale which blocks screens and drinkers.

Calcium is a nutrient and part of the pig's dietary need for calcium can be supplied by water. High calcium levels in water may interfere with absorption of phosphorus in the digestive tract. Calcium and phosphorus diet levels for pigs fed high-calcium water may need adjustment. Calcium contributes to water hardness, and can cause a build up of scale in screens and drinkers. The resulting reduction in water volume supplied to the pig can decrease performance.

Sulfate forms salts with calcium, sodium and magnesium. Pigs' tolerance of sulfate salts in increasing order is: (1) magnesium sulfate, (2) sodium sulfate, and (3) calcium sulfate. Another name for magnesium sulfate is Epsom Salts. Water containing 1,000 mg/l sulfates may cause scouring in young pigs. However, greater concentrations may be tolerated depending on pig age, presence of other stresses, and the type of sulfate salt in the water. Canadian guidelines suggest that sulfate levels should not exceed 1,000 mg/l.

Pig performance may be affected by high-sulfate waters. Research has shown that pigs can drink water containing more than 2000 mg/l of sulfates without any effect on growth rate or feed efficiency. A recent study by the Prairie Swine Centre showed that water containing 2650 mg/l sulfates decreased feed conversion in weanling pigs fed a non-medicated diet.

Fluoride is not an essential nutrient. In low concentrations, it does not affect livestock performance or health. Fluoride tends to collect in bone tissue instead of muscle, and can cause tooth and bone damage in growing animals (especially cattle) when consumed in great amounts. Pigs can safely consume 70-100 mg/kg of dietary fluoride.

Salinity is a measure of all salts dissolved in the water. Canadian guidelines suggest that salt concentrations should not exceed 3,000 mg/l; Australia suggests a maximum concentration of 6,000 mg/l salt. Pigs can adjust to saline water if the adjustment period occurs over several weeks. A sudden change from low- to high- saline water can cause death. Table 2 shows the use of saline waters for pigs.

TABLE 2. Use of Saline Waters for Pigs.

Salt Level (mg/l)	Effect
< 1,000	- SAFE for all pigs
1,000-3,000	- some diarrhea initially - should not affect health and performance
3,000-5,000	- may cause temporary refusal of water and mild diarrhea initially
5,000-7,000	- should not be used by lactating or pregnant sows
7,000-10,000	- UNFIT for most pigs
>10,000	- SHOULD NOT BE USED AT ALL

Source: Canadian Water Quality Guidelines - Canadian Council of Resource and Environment Ministers, 1987.

Key: < means less than; > means greater than.

Sodium is commonly found in groundwater and by itself, poses little threat to a pig's health. However, if sodium is present with sulfate, scouring and a decrease in performance can occur (see comments on sulfate). Scouring caused by high-sodium sulfate water can be reduced by small decreases in dietary salt as long as the resulting chloride level meets the pig's dietary requirement.

Chloride by itself has little effect on pig performance. The maximum recommended chloride level of 250 mg/l for people is based on taste, not health hazard. As chloride levels of water are often lower than sodium levels, any decreases in dietary salt (sodium chloride) must be done with caution or a chloride deficiency can result. Very high chloride levels may indicate a pollution problem.

Potassium is commonly found in the environment, but is rarely found in groundwater above a level of 50 mg/l because potassium binds tightly to the clay fraction of soils.

Nitrates ($N0_3$) and nitrites ($N0_2$) are well tolerated by pigs since pigs lack the ability to convert nitrates to the toxic nitrite form. Nitrites join with haemoglobin to form methaemoglobin, thereby reducing the oxygen capacity of the blood (causing blue baby syndrome in humans). The recommended maximum nitrate and nitrite levels of water are conservative since several studies have shown that pigs (including newly weaned) can tolerate 1320 mg/l nitrates and 165 mg/l nitrites without loss of health, growth rate or reproductive performance. As both feed and water can contain nitrates and nitrites, both sources must be considered when investigating a possible poisoning.

Iron is an essential nutrient. As iron concentration in water is far below toxic levels, no guidelines have been established for livestock watering. Iron concentration affects the water delivery system. When groundwater is pumped to the surface, the presence of oxygen converts soluble iron into insoluble iron (which causes rust stains in sinks). If iron-fixing bacteria are present in the well, they produce a red slime which can clog water lines, screens, and even the well casing. As the bacteria can be introduced during the drilling process, all equipment should be disinfected after each well is completed.

Blue-green Algae produces a toxin which can kill livestock and poultry. Livestock and water fowl poisoning from algae toxins are more common in western Canada. Pigs should not be given water from sources which contain heavy algae growths.

pH of groundwater is normally 7.4 to 8.8. Pig performance is not directly affected by pH; however, pH affects how well chlorine acts as a bacterial agent. The higher the pH, the less effective chlorination will be in fighting a bacterial problem.

Taste, Odor, Color or Pollution Problems contact the **Ministry of the Environment (MOE)** for help. Your regional MOE office is listed in the blue pages of your local phone book. If the water quality problem is known to be a natural characteristic of the **aquifer** (such as high iron or sulfate levels), the producer may be referred to a private lab

or treatment consultant. If a producer suspects a pollution problem (such as leakage from a nearby landfill site), MOE will take water samples at his farm. Depending on the results, they may ask OMAF for help with finding and correcting the source of the problem.

TESTING FOR WATER QUALITY

A water sample should be sent to a commercial laboratory for routine analysis about 4 times per year (i.e. in March, June, September and December) in order to establish background information about the seasonal nature of the aquifer(s) supplying the farm. Such information then makes a pollution problem easier to detect.

Substances which should be routinely tested for include: calcium, magnesium, potassium, sodium, chloride, sulfate, bicarbonate, nitrates, alkalinity, pH and conductivity. The cost of such analyses will vary from $14 to $35 per sample depending on the analysis packages offered by different laboratories.

A list of accredited laboratories for water analysis can be obtained from your local OMAF office.

Note: MOE will only test your water in the event of a suspected problem – for routine water testing, contact your nearest commercial laboratory.

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ISSN 0225-7882